NOAA's Science Advisory Board (SAB) Ecosystem Science and Management Working Group (ESMWG) Recommendations on the NOAA Ocean Color Satellite Continuity Mitigation Plan

1. NOAA should initiate and pursue discussions with NASA for an ocean color mitigation partnership to build on lessons learned in particular from SeaWiFS and MODIS and with an initial focus on the wide-swath data. The partnership organization should be independent of the NPOESS Integrated Program Office (IPO), but IPO participation should be encouraged. To further develop NOAA capabilities for processing and analyzing satellite ocean color imagery, a near-term option for the partnership should be a real or virtual "center" involving NOAA and NASA personnel and with contributions from the academic research community. An important step in any research to operations transition is for researchers to work directly with those developing operational capabilities. Thus, Center activities should include: research and development related to ocean color products to serve research and operational users; processing/reprocessing of data from U.S. and international sensors to ensure a sustained time series of calibrated imagery to identify long-term trends; and calibration and validation activities involving, for example, a new NOAA-operated "MOBY" (sophisticated bio-optical buoy) and other activities.

Response: Agreed

a) NOAA is working with NASA, NSF, and ONR to help build consensus within the greater ocean color community regarding the national needs for ocean color observations from space, as well as the observational requirements necessary to meet those needs. Specifically, the 4 agencies have initiated a study with the Nation Research Council (NRC) Ocean Studies Board Study, 'Assessing Requirements for Sustained Ocean Color Research and Operations'. The study began in September 2009 and a prepublication report is scheduled for February 2011. Objectives include:
   - Identify research and operational needs and the associated sensor and system requirements for a sustained, systematic capability to observe ocean color radiance (OCR) from space;
   - Review the capability of current and planned national and international sensors in meeting these requirements;
   - Identify and assess the gaps and options for filling gaps between the current/planned sensor capabilities and the requirements for future oceanographic research and operational needs;
   - Identify and describe requirements for a sustained calibration and data validation program;
   - Identify requirements for a sustained, long-term program within the United States for the maintenance and improvement of associated ocean color data records, which ensures continuity and overlap between sensors, including plans for sustained rigorous inter-calibration and data validation; algorithm development and evaluation; data processing, re-processing, distribution and archiving; as well as recommended funding levels for research and operational use of the data.

b) We have also recently implemented a Joint NASA-NOAA Ocean Color Radiometry Technical Working Group, approved by NASA and NOAA as part of their broader Joint Working Group on Research to Operations, to formally coordinate and facilitate ocean color technical activities; the agreed-to, formal Terms of Reference are:

- To construct a partnership and serve as a communication and coordination channel between NASA and NOAA scientists and engineers, working as part of the global community of providers and users of satellite ocean color radiometry data, that will facilitate the timely, ongoing development and transition of ocean color capabilities from research into operations and maximize benefits from U.S. government investments in ocean-color science and technology.
- To coordinate on technical issues related to domestic ocean color radiometry data and facilitate the continuity of climate quality ocean color radiometry data and development of community consensus climate data records.
- To coordinate the U.S. acquisition, processing, and distribution of foreign ocean color radiometry data.
- To coordinate U.S. Government support and implementation of the CEOS-GEO Ocean Color Radiometry Virtual Constellation that will harmonize the international effort.
- To coordinate NOAA's engagement in future NASA research missions and facilitate timely transition from research into operations.

This effort represents an initial starting point for our formal collaboration/communication with NASA, and represents a significant step towards a broader partnership as envisioned in the future, potentially evolving into a real or virtual NASA-NOAA ocean color radiometry center. Further details on specific activities, schedule and approach of this Joint NASA-NOAA Ocean Color Radiometry Technical Working Group will be discussed at the next NASA-NOAA Joint Working Group on Research to Operations meeting, scheduled for December 2, 2010. To complement the above joint NASA-NOAA Ocean Color Radiometry Working Group, we will also initiate a cross-line office Ocean Color Data Users and Providers Working Group within NOAA to facilitate communication and coordination across the line offices to ensure that user needs and requirements are being adequately addressed. A subset of this group will constitute the NOAA contingent of the Joint NASA-NOAA Ocean Color Radiometry Technical Working Group. Additional articulation of coordinated activities is anticipated following the NRC pre-publication ocean color report in February 2010. An update with further details in the above context will be provided to the SAB in FY11 Q2/3.

c) There has been a major restructuring of the National Polar-orbiting Operational Environmental Satellite System (NPOESS). A new Joint Polar Satellite System (JPSS) Program is being developed by NOAA in partnership with NASA; the IPO ceased to exist as of 30 September 2010. As part of the emerging JPSS structure, a Data Products and Algorithm Group will be led by the NOAA/NESDIS Center for Satellite Applications and Research (STAR), with a number of science product/application teams, including ocean color, to be implemented and chaired by STAR scientists. The activities of the Data Products and Algorithm Group science application teams (ocean color et al.) will be coordinated and communicated with the broader research and user communities. STAR scientists are presently working to ensure the continuity of MOBY operations under the purview of this JPSS Group, and likewise the development of and transition to the next generation MOBY platform (i.e., MOBY-C). Further details on the approach, organization and activities of the JPSS Data Products and Algorithm Group, particularly as

it pertains to the ocean color science application team, will be shared with the SAB once the specifics have been finalized within the JPSS Program (presently anticipated in the FY11 Q2 timeframe).

2. NOAA should conduct a full Analysis of Alternatives for full NOAA ocean color requirements with a particular focus as to how best to extend routine ocean color measurements into coastal and estuarine waters. This study should consider an optimum mix of in situ, aircraft and satellite assets, including imagery from satellites operated by ESA at present and in the future that can provide 300m X 300m pixel resolution imagery. Imaging coastal waters with sensors having higher spatial resolution than SeaWiFS or MODIS in support of NOAA missions could significantly enhance the return on investment (ROI) from satellite ocean color data.

Response: Agreed

a) The NOAA Ocean Color Satellite Continuity Mitigation Plan (completed October 7, 2009, revised in support of the NRC ocean color study on April 20, 2010) studied various missions of the Ocean Color Radiometry-Virtual Constellation (OCR-VC) and identified a number of suggestions for providing sustained operational ocean color observations up to and during NPOESS C1 (now JPSS-1) in 2014.

b) Before NOAA looks at non-satellite platforms – ships, buoys, aircraft, etc – we have asked the NRC to provide input concerning this issue, specifically: "Identify and describe requirements for a sustained, rigorous calibration and data validation program, which incorporates a mix of measurement platforms (e.g., satellites, aircraft, and in situ platforms such as ships [e.g., minimal set of routine underway observations to support ocean color] and buoys) using a layered approach through an assessment of needs for multiple data user communities." Once we have NRC input, we will be able to address the best way forward, potentially to include a more comprehensive/exhaustive Analysis of Alternatives building upon the aforementioned Ocean Color Satellite Continuity Mitigation Plan.

c) Progress is being made in the acquisition and distribution of full resolution ocean color radiometry data/products (order 300m resolution local area coverage, vice order 4 km resolution for global area coverage data):
    a. NOAA is a Champion User and Science Team Member in the ESA CoastColour Program.
    b. NOAA is acquiring and distributing experimental, native MERIS data and imagery at full resolution for U.S. coastal waters via CoastWatch and supporting other USG and academic sources. Also, NOS routinely processes, analyzes, and provides MERIS full resolution data to managers in OH, FL, and MD for HAB activities.
    c. NOAA is negotiating, in collaboration with NASA, with ISRO to acquire OCM-2 full resolution data for U.S. coastal waters via direct broadcast.
    d. NOAA is beginning advanced planning (with associated budget initiatives) for acquisition and distribution of full resolution data and products from ESA's Sentinel-3 (OLCI) and GCOM-C (S-GLI).

3. NOAA/NESDIS should continue to encourage and support the Committee for Earth Observation Satellites (CEOS)-approved Ocean Color Radiometry Virtual Constellation (OCR-VC). Virtual Constellations are a new CEOS approach to improve cooperation among international agencies for global satellite and other measurements relevant to societal benefit areas defined by the Group on Earth Observations (GEO). The OCR-VC is a federation of those international agencies interested in satellite ocean color observations, and most of the international space agencies are now participating in the OCR-VC and cooperating with its activities. Although the OCR-VC is not an independent implementing organization with an independent budget, its activities will help facilitate NOAA access to satellite ocean color and other data collected by non-U.S. agencies.

Response: Agreed

NOAA has actively encouraged and supported the Committee on Earth Observation Satellites (CEOS) in their establishment of an Ocean Color Radiometry Virtual Constellation (OCR-VC), which was approved by CEOS a year ago.

NOAA contributed to the OCR-VC Implementation Strategy and Plan Phase I document dated 23 September 2009, and has a number of supporting tasks across the multiple objectives of this plan, including as identified in the plan:

- Working to improve VIIRS and VIIRS data quality: this includes improved filter construction for JPSS-1/VIIRS to mitigate cross-talk issues; NIST T-SIRCUS testing for laser characterization of in-band and out of band VIIRS visible and NIR channels; continued execution of the previously developed IPO Ocean EDR Product Cal/Val Plan; actively pursuing updating of the OCR algorithm; and, development of NOAA unique ocean color products (e.g., SWIR coastal products).
- Working to sustain MOBY which is crucial for providing high quality data for vicarious calibration of domestic and international OCR sensors; also working to transition to the next generation MOBY optics and platform (i.e., MOBY-C).
- Participating in the ESA CoastColour Project as a Champion User and Science Team Member;
- Developing an OceanWatch portal for VIIRS and possibly international sensors that will provide access to space-based observations of the global ocean for operations and climate applications.
- Participating in various related GEOSS and International Ocean Colour Coordinating Group (IOCCG) Working Group activities, e.g., remote sensing of coastal water quality

NOAA has and will continue to actively support this important international, multi-agency OCR-VC initiative as it continues to evolve in the future.